Ecosystems Effects on Software-Consuming Organizations: an experience report on two observational studies

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ABSTRACT

Software engineers should have the ability to abstract the complexity of a whole system composed of products, demands and suppliers emerging from an interconnected network termed a software ecosystem (SECO). Since software suppliers resort to virtual integration, software-consuming organizations face difficulties performing IT management activities and analyzing what application or technology enter their SECO. In this context, the 'silent' effects of nontechnical factors give rise to serious long-term problems, e.g., low productivity, investment loss, financial crisis, or bankruptcy. This paper presents an investigation of SECO effects on software-consuming organizations performing IT management activities in real settings. IT management teams have regular meetings to deliberate on acquisition decisions which they base on experience and IT market recommendations, including spreadsheets and distributed documents. Analysis of the decision space, business objective synergy, and technology/supplier dependency are identified as the most critical health indicators for SECO platform monitoring in IT management activities. This highlights the critical role acquisition preparation plays in the SECO context.

CCS CONCEPTS

• **Software and its engineering** → **Software architectures** • *Information systems* → *Computing platform*

KEYWORDS

Software Ecosystems, IT Management, Acquisition, Software-Consuming Organizations, Governance, Observational Studies.

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1 Introduction

Software Engineering (SE) has supported the global industry with methods, techniques and tools to develop interconnected, large-scale software-intensive systems in a rapid speed of deployment and evolution [1]. According to Boehm [2], the main goal of SE field is to create products that add value to society. The way different interests and expectations are communicated is critical for the manner stakeholders are understood, affecting how solutions meet their needs. Large-scale development processes are complex, slow, expensive, and unpredictable [3]. As such, researchers and practitioners need to cope with the economic and social issues in SE [4, 5], for example:

- *software development requires attention to the platforms and socio-technical networks*: connectivity and dependency relationships increasingly affect IT management decisions;
- *business success no longer depends on a single organization*: objective synergy/alignment are critical for the satisfaction of stakeholders' demands and for innovation in the production.

As stated by Serebrenik and Mens [6], software engineers should have the ability to abstract the complexity of the whole system composed of products, demands and suppliers emerging from an interconnected network termed a software ecosystem (SECO). The metaphor of ecosystems highlights three areas [7]: *acquisition*: developing/acquiring software to sustain an evolving organization's platform; *governance*: managing software assets to support decisions in the development processes; and *socialization*: analyzing socio-technical networks to monitor health and meet stakeholders' needs. Since suppliers resort to virtual integration [8], software-consuming organizations face difficulties in performing IT management activities and specifically analyzing what application or technology enters their SECO.

In this context, Fotrousi et al. [9] have identified some IT management issues: (1) strategic problems derived from interests-expectations mismatch that are critical to prepare an organization to understand demands; and (2) tactics and methodology problems in demand-solution matching. Thus, transitioning from traditional relationships and structures to the SECO context affects business/technical specification and design choices [10]. It means that SECO affects IT management activities with regard to the software-consuming organization's demands and solutions, since it entails complex acquirer-supplier relationships [11]. The 'silent' effects of such nontechnical factors give rise to serious long-term problems that affect SECO health. This is a consequence of a decision-making mindset that focuses on subsistence (short-term) instead of sustainability (long-term). In this case, monitoring SECO health indicators can aid organizations' decisions [8], supporting the work of IT managers and architects over time.

This paper presents an investigation of SECO effects on software-consuming organizations performing IT management activities in real scenarios. Firstly, we explain the method we used to conduct observational studies [12] in two Brazilian real cases where different organizations create an ecosystem platform based on applications and technologies they acquire over time (Section 2). In Sections 3 and 4, we characterize each case and discuss the ecosystem setting to answer our research question. Section 5 discusses our findings and Section 6 presents threats to validity. In Section 7, we summarize critical health indicators that affect IT management activities in the SECO context.

2 Method

From previous systematic mappings on SECO [5, 7], researchers have reported that IT management activities in software-consuming organizations have been affected by the SECO context. Specifically, the adoption of new software faces barriers, such as market penetration and acceptance, and technology maturity [13]. This reality motivated us to perform two observational studies to identify the main SECO effects on software-consuming organizations performing IT management activities. Using the Goal-Question-Metric method, this work **analyzes** IT management activities on software acquisition **with the purpose of** characterizing SECO effects **with respect to** the identification of critical health indicators **from the point of view of** IT managers/architects **in the context of** Brazilian real cases. Our research question is: "*What are SECO effects on software-consuming organizations performing IT management activities?*".

That study, adopting Seaman's guidelines [12], allowed us to capture first-hand, behaviors and interactions that might not otherwise be noticed. An observational study (participant's observation) refers to a research that involves social interaction between the researcher (observer or investigator) and informants in the milieu of the latter. Data are collected systematically and unobtrusively during the study [14]. Both observational studies followed recommendations adapted from [12] (Table 1).

Some reasons to conduct a qualitative research are suggested by Hancock et al. [15]: (i) it studies behavior in natural settings; (ii) it focuses on reporting experience which cannot be adequately expressed numerically; (iii) it focuses on how informants can have different ways of looking at reality; (iv) it focuses on description and interpretation (leading to an evaluation of an organizational process); (v) it considers complexity by incorporating real-world context; and (vi) it uses a flexible methodology. In the SECO field, researchers have adopted qualitative research to observe real situations, as reported by a longitudinal literature study [7].

The questions identifying the SECO challenging areas (i.e., acquisition, governance, socialization) [7] presented in Section 1 guided the researchers throughout the study which was conducted over different periods, as detailed in Sections 3 and 4. We selected two Brazilian cases to perform our studies, because they are examples of SECO centered on large software-consuming organizations and the researchers had access to their stakeholders. In both cases, at least one researcher was engaged in some activities while participants were observed, although this is not mandatory [12]. For each study, one or two researchers attended project meetings (sessions) in a specific timeframe (weekly or monthly) with different stakeholders (users, clients, requirements engineers, architects, developers, test engineers, suppliers, project managers, and IT consultants). The researchers wrote down all observations they could, i.e., impressions, opinions and thoughts in a notebook.

Table 1: Recommendations on observational studies [12]

SITUATION	RECOMMENDATION
much of software development activities are implicit and some key-stakeholders keep important information in their mind	*Communication* is the best resource for a researcher to observe the IT management activities, taking part of project meetings and requesting short meetings.
informants can think they are being observed throughout the study activities	*Notes* are the best resources for a researcher to register "normal" behavior of informants, and project meetings should be as unobtrusive as possible.
notes are often visible to some informants throughout the study activities	*Attention* is the best advice for a researcher to keep his/her notes confidential and has freedom to write down his/her own impressions, opinions and thoughts (notes can be shared with informants in the triangulation phase).
different meetings and sessions can freely happen throughout the study activities	*Emails* are the best resources for a researcher to gather data on meetings dates and times since he/she is trying to attend them as lifelike as possible.
different issues are usually discussed in a project meeting beyond the initial outline	*Text marks* are the best resources for a researcher to check relevant information since he/she should write down observations as much as he/she can.

After each study, one researcher organized the data collected in the sessions to classify and analyze relevant information with another researcher into the following categories:

(Q1) **Acquisition**: How are software demand and solution analyses performed by the software-consuming organization?

(Q2) **Governance**: How is the software asset base organized to support IT management activities?

(Q3) **Socialization**: How is the supply network organized to support IT management activities?

3 Case 1: Scientific SECO

The Observational Study 1 was conducted between July 2010 and December 2012 through monthly project meetings (two hours each). Next, there was a mentoring phase until December 2013 (one year). One researcher took part as project manager and requirements engineer. In this case, the software-acquiring organization consisted of a consortium of ten research laboratories (universities or scientific foundations) within the State of Rio de Janeiro, Brazil, joining approximately a hundred researchers. This consortium consists of a scientific SECO in the public policy domain. The IT management activities concerned the acquisition of a content management system and some components to support a scientific ecosystem focused on knowledge sharing and collaboration. Five candidate solutions (software product and components) were analyzed. Stakeholders with diverse backgrounds took part in this consortium, including geographers, social scientists, architects, life science researchers, managers, computer scientists, and software engineers.

3.1 Characterization

The consortium was created over the first semester of 2010. The first goal was to develop a central platform (web portal) to help the laboratories to share their research artifacts (e.g., videos, interviews, news, books, articles, thesis etc.) and to enhance their collaborative initiatives through communication and coordination mechanisms. Three roles were identified: (i) *producers*: students, researchers and professors who are responsible for developing, publishing and maintaining research artifacts within the scientific SECO; (ii) *consumers*: students, researchers and professors who are responsible for downloading, evaluating and (re)using research artifacts within the scientific ecosystem; and (iii) *repository managers*: IT management team responsible for managing the quality of research artifacts and for supporting the platform (portal and plug-ins management). According to repository managers, after some initial meetings, it was clear that laboratories were trying to create a scientific SECO. A closed network should be strengthened before opening it up to allow other organizations to participate in, such as libraries, governmental institutions, investors etc.

In September 2010, an IT management team was created to manage demands for the development/acquisition of platform's components (software applications). This committee was formed by one member of each laboratory and by six software engineers from the Software Reuse Lab at COPPE/UFRJ. An IT architect, a project manager, a web designer, two requirements engineering interns and a testing engineering intern composed this technical team. From September 2010 to June 2011, monthly seminars were promoted to identify demands and develop a prototype. All laboratories explained their needs aiming to help the IT management team to specify the platform's components and get commitment of the ecosystem's members. The main components identified and prioritized during the seminars sessions were: (i) communication management (support to users, laboratories, news, and links); (ii) authentication/security; (iii) events and conferences support; (iv) component repository storage, publishing, search and retrieval mechanisms (for all types of artifacts, e.g., videos, audios, texts, databases); and (iv) accounting management.

In February 2011, the IT management team was asked to decide whether the consortium should configure/use FOSS solution, buy COTS software, or develop/extend a platform from scratch or use the component-based paradigm. After analyzing the list of platform functions, five candidate solutions were identified: (i) configure and deploy a web portal based on the Joomla platform with plug-ins to meet the ecosystem's demands; (ii) configure and deploy a web portal based on the Moodle platform, which is broadly supporting communities in the learning domain; (iii) configure and deploy a web portal based on the Sakai platform, which is also supporting communities in the learning domain; (iv) extend a Software Reuse Lab platform called EduSE Portal [10] with plug-ins to meet the ecosystem's demands; or (v) contract a supplier to develop a web portal based on well-known frameworks/technologies supported by the IT management team.

After a seminar in March 2011, Joomla was chosen as the supporting technology. However, software engineers of the IT management team faced difficulties in meeting users' demands with such technologies. In a seminar in April 2011, ecosystem's members started criticizing the graphical user interface of the communication management component. This situation motivated the IT management team to realign stakeholders' expectations and consortium's interests. Then, the team decided to develop a requirements specification to aid decision-making. In June 2011, the committee delivered the first version of a formal requirements specification, which included the following sections: problem definition, platform scope, software and hardware interfaces, platform's functionalities, list of users, data dictionary, functional and non-functional requirements lists, use cases, and mockups.

Considering the specifics of the ecosystem's platform, the consortium voted for the development of a web portal based on well-known frameworks and Java technology, being supported by the IT management team. A supplier was selected by its expertise in the software development community and content management portals. The platform development started in July 2011. Three main players took part in the iterative-incremental development process: (i) *supplier*: external organization responsible for coding and evolving the platform, and for integrating web design templates; (ii) *IT management team*, representing the consortium: responsible for performing four activities – project management, web design, requirements management, and testing activities; and (iii) *laboratories' members*: responsible for validating functionalities implemented in the platform. The requirements specification had been evolved throughout the development of the platform, which was concluded in December 2012 (1.5 year).

The platform was released and deployed in January 2013. Some remaining issues were fixed in the first semester of 2013 when laboratories' members started publishing and downloading research artifacts and platform's plugin-ins. The IT committee was redefined since development activities on the platform's kernel were not required after it entered in operation. After three years of tightly collaborative activities within the emerging ecosystem, other laboratories started contributing to the opening network. In addition, a new platform focused on public policy in education was derived from the scientific SECO. This new platform tried to follow the same trajectory of the previous one and components (plug-ins and extensions) were developed to meet specific domain demands. This platform was under development until 2017 and it is stable now.

3.2 Analysis

Case 1 allowed us to observe two main challenges: *communication* and *autonomy*. Since ecosystem's members worked in different geographic locations and had different backgrounds, it was very hard to make convergent decisions on the components to be acquired. The senior researcher who managed the consortium then explicitly required that at least one member of each laboratory to attend the monthly seminars, especially in the first year – when the platform was created. Different backgrounds make requirements communication very difficult, for example when coping with software development terms, e.g., 'web design' (software engineers) against 'visual identity' (social science researchers). As such, another responsibility of the IT management team was to not only align stakeholders' expectations but also respect their expertise, preserve their autonomy, and bring them into the development process to make them feel as critical players (decision makers).

With respect to the acquisition perspective (Q1), Case 1 allowed us to observe two main challenges: *future demands* and *inter-organizational validation*. Demand analysis remains a critical issue in IT management [16]. Deciding which demands are currently more valuable for the most important stakeholders is not a simple task, especially if the software project is cancelled. Sometimes it was very difficult to convince ecosystem members that platform evolution should prioritize what was important to leverage the scientific SECO and hence that some demands would translate into what they deemed 'non-useful' functionalities, e.g., integrating a chat mechanism into the platform given that most members use well known chat systems (Gtalk, Skype, Messenger). The IT management team faced barriers in orchestrating validation activities because different ecosystem's members had different perceptions of functionalities. However, it can be very positive for verification activities (functional testing) since different users had contributed to test platform's components and identified/reported software bugs, interface mismatching etc.

Case 1 allowed us to observe two main challenges relevant to the governance perspective (Q2): *solution analysis* and *user recommendations*. When the IT management team performed a feasibility study to decide on the platform development strategy, it was clear that most of the ecosystem' members recommended checking market reports on "content and community management systems". Traditional IT advisory companies such as Gartner and Forrester produce reports on technology maturity and trends. Following market indicators, the IT management team ended up developing the platform based on component-based frameworks and technologies (Java, HSQLDB, JSF2, Richfaces 4, EJB 3.1). Another relevant criterion was to seek user ratings (i.e., evaluations/suggestions) regarding each candidate solution. To do so, software engineers collected strengthens and weaknesses of existing web portals that support similar ecosystems.

Finally, with respect to the socialization perspective (Q3), Case 1 allowed us to observe two main challenges: *development with reuse* and *hybrid development process*. After failing attempts to configure Joomla to support the SECO demands, the IT management team had decided to develop a structured requirements specification to coordinate the set of demands concretely. The decision on the development of the platform kernel with a software supplier considered its expertise on frameworks and technologies that improve time-to-market. As such, existing mechanisms were reused and integrated over the platform development. In parallel, an iterative-incremental development process was adopted, combining some practices, e.g., useful items of requirements specification (use cases), prototyping, 4-week iterations, biweekly project's meetings with the supplier and IT committee, monthly consortium's seminars with the ecosystem's members etc. This was critical to align stakeholders' expectations, change priorities, get feedback, measure project's performance, and adjust plans.

4 Case 2: Governmental SECO

Observational Study 2 (Case 2) was conducted between May 2013 and April 2014 through semester (2013) and monthly (2014) project meetings, and from March 2015 to February 2016 through a software development project. Next, there was a mentoring phase until January 2017 (one year). In this scenario, the software-acquiring organization consisted of a consortium of dozens of departments within the Federal District, Brazil, joining approximately a hundred practitioners. This organization consists of a governmental SECO in the public management domain, i.e., an ecosystem centered in management information systems with a network of business units and suppliers supported by public founding. The IT management activities referred to acquire applications and technologies to create a governmental SECO to support public management focused on improving participatory democracy. Several software solutions (mostly web information systems) are weekly analyzed aiming to support e-gov. A process to support the ecosystem's product management was mapped and modeled based on agile development for large corporations. Stakeholders with diverse roles took part in this consortium, such as managers, directors, coordinators, suppliers, consultants, clients, end-users, and computer scientists.

4.1 Characterization

In 2012, the IT management team decided to devote effort to understand how the software process was daily performed. This team realized that the organization was adopting an agile approach over the unified process often implemented in public corporations, producing a hybrid process. Then, the organization decided to model such dynamic, "organic" software process aiming to share process knowledge and practices as well as collectively maintain it over time. In May 2013, the first project meeting focused on analyzing previous process modeling initiatives from Business Process Model and Notation (BPMN). It was observed that the process was not as dynamic as they wished, and most stakeholders had no idea on how to get it or use it in practice. The main roles were identified: (i) *Systems Sector*: responsible for analyzing, selecting, prioritizing, managing, and concluding demands requested by the organization, acting as project managers; (ii) *Business Areas*: departments or sectors within the organization responsible for demanding software solutions, playing as clients; and (iii) *Suppliers*: organizations responsible for developing solutions or selling COTS software that are/will be managed by the Systems Sector.

After some political issues related to reprioritization of investments, a second project meeting was performed in October 2013 aiming at exploring ways to sustain the hybrid software process focused on software artifacts. In that occasion, the IT management team and the process engineer together discussed how SECO modeling and analysis might help the organization to understand the software process. Therefore, the Systems Sector's coordinator proposed a strategy and a roadmap to get first useful results of software process modelling. Initially, Systems Sector's analysts and the process engineer investigated approaches for agile-driven, hybrid process modeling over three months, keeping a monthly videoconference meeting. Between January and April 2014, monthly one-week observational sessions were performed, starting with a workshop on process definition and modeling (January). The workshop produced a conceptual map and an initial model based on Software & Systems Process Engineering Metamodel (SPEM), Eclipse Process Framework (EPF), and Disciplined Agile Delivery process framework (DAD).

Besides the workshop in January 2014, some sections of the observational study were conducted in the context of diverse software projects' meetings involving clients, suppliers, project managers, consultants etc. until April 2014. Some observations collected from the sessions are described next. First, the organization recognized some areas of interest (management of software processes, application portfolio, acquisition/monitoring contracts, and IT services), as identified in the workshop discussions. As such, it was required support in SE education and training in order to identify effective ways of disseminating and institutionalizing its software process.

Moreover, the Systems Sector was driven by frequent releases, shortening time-to-market and agile practices, leading several geographically distributed suppliers and facing collaboration challenges. In this scenario, the IT management team maintained a reference architecture as a set of applications and technologies organized into categories (taxonomy), guided by market and IT advisory companies. In addition, the acquisition process was supported by a diagnosis phase as part of the software process that aims to perform a feasibility study to decide whether to make, buy or reuse software solutions.

A critical issue is that the organization had faced reprioritization decisions over time, e.g., some on-going projects might be canceled. Then, demand selection and prioritization are crucial to early earn value. Since the organization has a structural role within a governmental SECO and try to reduce acquisition costs while sustaining solutions through collaborative software projects, it had also faced political issues. Besides, it had no clear governance on SECO elements and frequently requires reevaluation of application portfolio due to scarce resources. A triennial IT investment plan (roadmap) is then produced to define which software demands should be executed and which should not. Finally, the System Sector had faced some barriers in running a hybrid process since contracts were specified in function points and projects were managed through an agile approach.

The first version of the hybrid software process was concluded between May and June 2014. It focused on modeling all the process elements of the System Sector (i.e., activities, roles and work items). It was quite difficult to understand and some process areas remained unexplored, such as make-buy-reuse analysis, since there was no inventory to leverage a software asset governance strategy. Reprioritization seemed to be a recurrent situation. Moreover, the potential process line approach was not explored yet. It could contribute to the dissemination and institutionalization of the process, mainly because collaboration was also a challenge. So, from the first semester of 2015, the process had been analyzed again to create a "slim" version that was effectively applied, as well as to explore the application portfolio and collaboration activities to support the SECO. The ecosystem platform and its related process were released in 2017.

4.2 Analysis

Regarding the IT management activities performed by the organization, Case 2 allowed us to observe two main challenges: *roadmap development* and *contract monitoring*. In this context, all acquisition activities performed within the organization should be described in a triennial IT management plan consolidated with departments, institutions and sectors. Despite issues related to possible budget cuts, this document represents a high-level description of the organizational demands (an important guide to the IT management). As such, all contacts should be monitored in order to check to what extent all organizational demands had been solved. However, such precise control remains as a challenge, especially considering different clients running acquisitions rounds at the same time. Besides, since the System Sector had formal responsibility for monitoring function points counting, an organization specialized in doing so was hired.

Regarding the acquisition perspective (Q1), Case 2 allowed us to observe two main challenges: *process institutionalization* and *frequent reprioritization*. As mentioned before, the organization invested in hybrid software process modeling to support the System Sector to run projects. The process needed to be disseminated and institutionalized, but barriers referred to its "overloaded" nature, and difficulties to understand it still waited for solutions. As such, some stakeholders did not know how the process work and how to use it in practice. An issue related to requirements management was the frequent reprioritization of project portfolio due to budget cuts or interest change, mainly in political transition situations. Demand selection and prioritization affect (and are affected by) the organizational roadmap and the software project as well. Therefore, the System Sector coped with these issues by applying agile practices.

Regarding the governance perspective (Q2), Case 2 allowed us to observe two main challenges: *mature technology* and *education and training*. Similar to Case 1, the organization looked at market reports produced by IT advisory companies to justify some IT management decisions. In one session, a conference call between the System Sector's coordinator and a famous IT advisory company's analyst was performed to decide on the technology to support an enterprise service bus, for example. Another issue observed throughout the sessions was the demand for education and training in some relevant SE disciplines in the organizational context. This problem happened due to the high turnover that also affects process dissemination and institutionalization.

Regarding the socialization perspective (Q3), Case 2 allowed us to observe two main challenges: *reference architecture* and *hybrid development process*. In order to sustain all the solutions produced over time, the System Sector decided to define a reference IT architecture, i.e., a set of standard technologies grouped by categories. It makes software maintenance easy and reduces the learning curve bypassing the high turnover. However, this strategy required an IT architect team to be able to sustain and evolve it. As such, the organization started observing a network of technology suppliers surrounding the SECO because demands' specifications should consider technology constraints established in the reference architecture/'unrequired' dependencies. The hybrid process needed to support demand coordination, including activities related to the organizational scenario (project management) and to the ecosystem scenario (partner selection).

5 Discussion

In this section, we summarize our findings, as shown in Table 2. In Case 1, we observed some problems related to communication among stakeholders during the IT management activities regarding the acquisition preparation, which was collaborative and iterative. A possible reason is that they had different backgrounds and strategic decisions were based on monthly seminars with no requirement specification document at first. Additionally, IT management team faced challenges in classifying current and future business objectives due to the lack of synergy. Market reports and user ratings on content management systems available on the Internet were taken into consideration to choose mature supporting technologies. In this specific scenario, the organization preferred to choose a closer supplier to develop a customized portal than an existing COTS solution.

In Case 2, we observed that the software process defined by the IT management team aimed at centralizing acquisition but some business areas disturbed it. In other words, short-term goals affected shared business objectives and caused frequent reprioritizations. Therefore, business areas prefer to pursuit specific software solutions rather than analyze their problems and feed organization's objectives. The same legal issues and the use of IT advisory company's market reports found in Case 1 apply. A particularity of this case is the priority of selecting Brazilian public software as well as FOSS solutions. Finally, this organization gets in trouble due to some dependencies on certain suppliers, e.g., high costs and poor support.

Considering the SECO management issues discussed in Section 1, we observed that there is an emerging concern with sustainability in SE, then acquisition preparation needs to take into account other criteria than available budget and requirement specification, as well as long-term rather than short-term IT management. In summary, regarding the elements that affect SECO platform sustainability, the main observations from our studies that helped us to collect data to answer our question are:

- *analysis of the decision space*: software-consuming organizations commonly do not know how to formally cope with several demands from its units at the same time. An inhibitor is the poor knowledge management that depends on different information, such as suppliers, existing applications and adopted technologies, producing obstacles to analyze acquisition impacts;
- *business objective synergy*: applications are normally acquired taking into account specific demands. Acquisition preparation is still a great challenge since each organizational unit has its own goals in its particular roadmap, producing obstacles to leverage socialization;
- *technology dependency*: market information on applications and technologies capabilities is not so useful as the only indication, though organizations hire IT advisory companies to guide their IT management decisions. Organizations often neglect the software asset base since they have no virtual catalog or inventory, producing obstacles to the governance of the SECO platform architecture;
- *supplier dependency*: similar applications are acquired from either third-parties or commercial suppliers or resellers. A purely cost-based, short-term approach is not so useful, because business, long-term information of the relationships within the supply network may be left out, producing obstacles to the SECO sustainability.

Table 2: Summary of data collected from each SECO case

	Case 1	Case 2
IT Management	Stakeholders worked in several geographic locations and had diverse backgrounds. Then, collaborative, nonsystematic specification was used to guide the acquisition preparation.	The organization developed a triannual roadmap consolidated with its departments and mostly focused on monitoring supplier agreements.
Acquisition (Q1)	An IT management team had biweekly meetings to prioritize shared business objectives, e.g., which of them should be postponed.	An IT management team had weekly meetings to coordinate shared business objectives into an informal portfolio that faces reprioritizations. Organization mostly focused short-term goals.
Governance (Q2)	The consortium selected the top mature FOSS solutions from specific forums available on the Internet to conduct a feasibility study.	The organization contracted an IT advisory company to obtain IT recommendations on the most appropriate technologies. Public, FOSS solutions were preferable.
Socialization (Q3)	In this case, the consortium decided to outsource the solution development. A supplier was chosen based on its background and previous collaboration/experience.	The organization contracted software factories based on bidding processes driven by the minimum cost as the key factor. Requirements specification was not formalized as a key factor.

6 Threats To Validity

Threats to validity include: (i) we have reported direct observations as a primary data collection method (nonsystematic analysis): we complemented them by collecting data from direct verifying IT management documents, e.g., triennial roadmap, request for proposal, demands' specifications etc.; also, two researchers analyzed the cases and solved any conflict of observation together; (ii) impressions, opinions and thoughts were subjectively reported in both cases: at least two researchers attended each meeting to reduce misunderstandings; notes written down in each meeting was sent to the IT management team for approval and then merged to a single description (triangulation); (iii) conclusions are limited to the cases' scenarios: in Case 2, for example, the organization is responsible for IT standardization and regulatory processes applied to other public organizations; therefore, the System Sector works with different scenarios and serves as a laboratory to explore process, methods and technologies to be adopted by the government IT; and (iv) it was not possible to represent all the situations of a SECO context, then studies in different organizations should be performed: unfortunately, research community commonly faces challenges in establishing many partnerships to collect real data and to evaluate proposed solutions. However, a strength of our study is the fact that we used a real dataset and took part in both SECO cases.

7 Conclusion

In this paper, we have reported on an investigation of SECO effects on software-consuming organizations performing IT management activities in real scenarios. We presented the results of two observational studies conducted in Brazilian cases where different units created a SECO platform based on software acquisition. We characterized each case and discussed SECO effects to answer our research question. Analysis of the decision space, business objective synergy, and technology/supplier dependency were the most critical health indicators for SECO platform monitoring in IT management activities. Additionally, demand and solution analysis seems to be very important for acquisition preparation and for maintaining a sustainable SECO.

Although selection and prioritization activities have been investigated in the SE area [17, 18, 19], two challenges for acquirer's IT management remain: (1) IT architectural matching taking into account supplier and technology dependencies over time [16]; and (2) multiple selections of software applications to help customers satisfy their business objectives [3]. According to Baker et al. [17], from the set of candidate components (in this case, demands and solutions), IT managers and architects should search for a subset that balances these competing, conflicting concerns to the greatest extent possible.

As observed, IT management teams had regular meetings to deliberate on those components based on their expertise and IT market recommendations, sometimes including spreadsheets and distributed documents. Acquisition preparation plays a critical role in the SECO context [20]. IT management teams considered requirement specifications and budget available as criteria to analyze demands and solutions since a structured asset base is missing, neglecting the 'hidden effects' of their long-term decisions. From a software-consuming organization perspective, such effects impact diversity, i.e., how sustainable the SECO platform is over changes such as technology obsolescence and business evolution. We have therefore developed a tool to assist IT managers and architects in performing demand and solution analysis [21]. Our longer-term goal is to distill a clear and useful theory out of the analysis.

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